ber septa **722** and **723** can be incorporated into orthogonal facets of chamber **705** to form a water-tight seal for engagement/disengagement.

[0117] In certain embodiments, actuators **702** and **703** can be housed in stainless steel needles **712** and **713** that will penetrate self-sealing rubber septa **722** and **723** built into tissue processing chamber **705**. In particular embodiments, two actuator/needle units can penetrate orthogonal sides of chamber **705** and can work together to move the tissue into any orientation. Once the tissue is in the chamber, a single actuator can penetrate the septum and a vacuum can be deployed. The actuator can be rotated and linearly translated via precision stepper motors to provide precise and accurate positioning of the specimen.

[0118] Vacuum suction can be applied to the hollow tube actuator at the same time saline is added to maintain a constant liquid volume. Once anchored to the actuator, the sample can be rotated fully about the deployed actuator axis and imaged using a visible wavelength camera. The second actuator can be deployed while the first actuator is disengaged, and the tissue can be imaged along the second actuator axis.

[0119] Optical systems interfacing with the tissue processing chamber can include an ultrafast laser, camera and OCT. An ultrafast laser (including for example, those available from Uranus-mJ, PolarOnyx Laser, USA) providing 1030 nm 500 fs pulses at a pulse energy of 0.5 mJ and repetition rate of 100 kHz on the specimen is utilized for rapid plasma ablation of tissue. The ultrafast laser beam can be combined with the OCT-MPL excitation beam by a dichroic mirror before the galvanometers. A CCD camera (including for example, acA1300-30 gc, Basler, Germany) at the back aperture of the objective can be used for tissue specimen alignment in the lateral plane, while OCT can be employed for specimen alignment in the axial plane. The ultrafast laser beam can be scanned in combination with actuator movement to trim edges of the tissue specimen to create a planar slab geometry with 500 μm thickness.

[0120] Exemplary embodiments of tissue processing system **700** can provide for efficient processing of tissue specimens and reduced processing times. In particular embodiments, a tissue specimen can be processed into a 500 μm thick planar slab geometry with two cut surfaces in less that sixty seconds (where the processing time is measured from the moment the tissue enters the processing chamber to the time when the ultrafast laser completes cutting the second planar interface).

[0121] Exemplary embodiments of the combined OCT-MPL fiber-based imaging systems (e.g. comprising swept-source OCT and MPL imaging modules and scanning optics) can be utilized to complete the image-based OCT-MPL assay.

[0122] In exemplary embodiments, an image-based OCT-MPL assay can be performed to demonstrate simultaneous detection of structure and composition of processed tissue slabs and diagnose whether cancer is present. Tumor tissues can be obtained from patients undergoing cancer surgery and MPL images recorded from both sides of the processed tissue slab and merged into a single volumetric image.

[0123] MPL images can indicate the presence of tissue constituents including lipids, calcium and collagen/elastin fibers. The energy state of the tissue can also be analyzed from the MPL signal including NADH and FAD+, which are involved in the Krebs cycle, since cancers will have an increased metabolic state compared to normal tissues. MPL emission spectra recorded (e.g. by photodetectors such as PMTs) can further distinguish these tissue types and redox states. Each co-registered en face OCT image can be merged with the MPL image to overlay biochemical composition onto the tissue OCT structural image. Inasmuch as OCT and MPL signals are due to two complementary types of optical contrast (e.g., scattering and multiphoton absorption/emission, respectively), regions with strong/weak MPL emission correspond to weak/strong OCT signal, providing a comprehensive interpretation of the processed tissue block. A three-dimensional OCT dataset can also be merged with corresponding MPL images, demonstrating three-dimensional distributions of tissue constituents and energy states in relation to surface profile and structure.

[0124] After completion of the image-based MPL-OCT assay, tissue slabs can be processed using standard histology for the presence of cancer by a pathologist. By comparing the histological diagnosis with the image-based MPL-OCT assay a training set that identifies diagnostic parameters in MPL-OCT images can be determined using principal components analysis (PCA). A number of recent studies suggest that multiphoton luminescence (MPL) and optical coherence tomography (OCT) can be used to detect cancer.

[0125] All of the devices, systems and/or methods disclosed and claimed herein can be made and executed without undue experimentation in light of the present disclosure. While the devices, systems and methods of this invention have been described in terms of particular embodiments, it will be apparent to those of skill in the art that variations may be applied to the devices, systems and/or methods in the steps or in the sequence of steps of the method described herein without departing from the concept, spirit and scope of the invention. All such similar substitutes and modifications apparent to those skilled in the art are deemed to be within the spirit, scope and concept of the invention as defined by the appended claims.

REFERENCES:

[0126] The contents of the following references are incorporated by reference herein:

[0127] Heidt A, *IEEE J. Select. Topics Quantum Electron,* 20 (5), 2014.
[0128] El-Sherif A, *Lasers Med Sci,* 18, 139-147, 2003.
[0129] Richardson D, J. *Opt. Soc. Am. B,* 27, B63-B92, 2010.
[0130] Yusuf S, *Circulation,* 104, 2746-2753, 2001.
[0131] Libby P, *Circulation,* 105,1135-1143, 2002.
[0132] Libby P, *Circulation,* 111, 3481-3488, 2005.
[0133] Lucas A R, *Circulation,* 113, e728-732, 2006.
[0134] Virmani R, J *Intery Cardiol,* 16(3), 267-272, 2003.
[0135] Davies M J, *Br Heart J,* 69, 377-381, 1993.
[0136] Stary H C, *Circulation,* 92, 1355-1374, 1995.
[0137] Jonasson L, *Arteriosclerosis,* 6, 131-138, 1986.
[0138] Johnson J L, *Proc Natl Acad Sci,* 102, 15575-15580, 2005.
[0139] Henney A M, *Proc Natl Acad Sci,* 88, 8154-8158, 1991.
[0140] Galis Z S, *J Clin Invest,* 94, 2493-2503, 1994.
[0141] Nikkari S T, *Circulation,* 92,1393-1398, 1995.
[0142] Libby P, *Curr Opin Lipidol,* 7, 330-335, 1996.
[0143] Taubman M B, 78, 200-204, 1997.
[0144] Kolodgie F D, *Heart,* 90, 1385-1391, 2004.
[0145] van Zandvoort M, *J Vasc Res,* 41, 54-63, 2004.